NOTICES FROM THE LICK OBSERVATORY.*

PREPARED BY MEMBERS OF THE STAFF.

CASTOR A QUADRUPLE STAR.

The second-magnitude star *Castor,* in the constellation *Gemini,* is known to all students of astronomy as a very interesting double star. In fact, Sir WILLIAM HERSCHEL, the pioneer of double-star astronomy, called it the largest and finest of all the double stars visible to observers in the northern hemisphere. It is also very interesting historically; for the motions in its system first convinced HERSCHEL that there are systems in which two or more bright stars are revolving around each other in orbits of short period.

The two component stars of *Castor* are a little brighter than the third and fourth magnitudes, respectively. They are about five and one half seconds of arc apart, and revolve around their common center of mass in approximately three hundred and fifty years, according to the latest calculations. An uncertainty of one hundred years at least exists in this estimate, for the reason that accurate observations of the relative positions of the two stars have been made for less than one hundred years.

An interesting discovery concerning the fainter of the two components of *Castor* was made, nine years ago, by Astronomer BÉLOPOLSKY, of the Russian National Observatory at Pulkowa. While engaged in measuring the speed with which the two components are traveling to or from the observer, he discovered that the speed of the fainter component is variable. On one night the star would move toward the solar system; on another night it would move rapidly in the opposite direction, and later it would prove to be rapidly approach-

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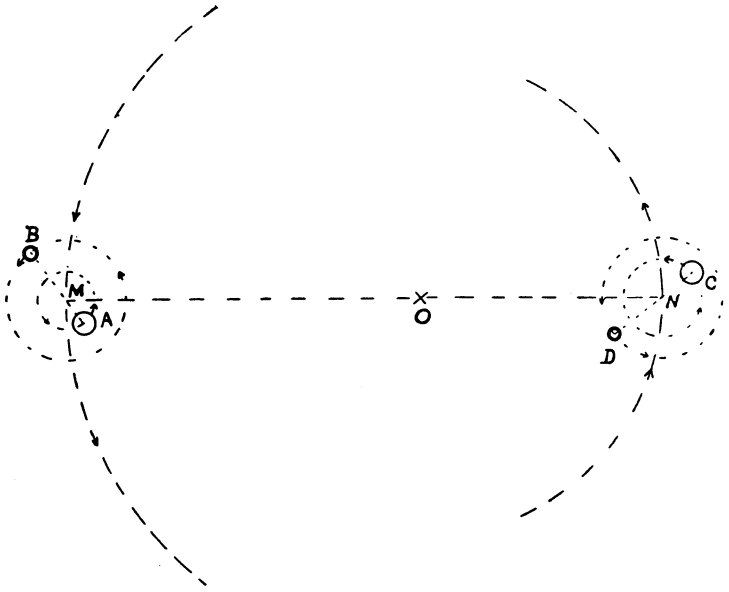
ing. A long series of observations has established that the speeds of this star pass through a complete cycle of change in a little less than three days. The explanation of the variable speed is, that this star is attended by an invisible and very close companion, massive enough to swing the bright star around in an elliptic orbit once every three days.

The purpose of this article is to call attention to the discovery, just made at the Lick Observatory, that the other and brighter component of *Castor* is likewise attended by an invisible component, which causes the speed of the bright star to



The System of *Castor*.

vary. At one time it is approaching us, and a few days later it is receding. The number of days required for the bright star and the invisible component to complete a revolution about their center of mass will not be known until a considerable number of observations have been secured, within the coming weeks. The discovery was made by Dr. CURTIS, using the Mills spectrograph attached to the 36-inch refractor.

In the accompanying illustration a rude attempt is made to illustrate the relationship of the stars in this system. A and C are the visible components of *Castor*. A is attended by

the invisible component B, discovered spectroscopically by BÉLOPOLSKY, and the two revolve around their center of mass, M, in slightly less than three days. The brighter star, C, is attended by the invisible companion, D, just discovered by Dr. CURTIS, and the two revolve around their center of mass, N, in a period as yet unknown. The two systems AB and CD revolve about their center of mass, O, in a period of approximately three hundred and fifty years. It should be said that the distances AB and CD are drawn relatively too large, and the distance MN vastly too small.

Great progress has been made in the study of double stars since the days of HERSCHEL. The known systems are numbered by the thousands, and the current work of Astronomers HUSSEY and AITKEN has established that, of stars brighter than the ninth magnitude, at least an average of one in eighteen is composed of two suns, visible in our great telescope. Although the components in each pair appear to be very close together, yet their distances from each other are so great, in all cases. that many years are required to complete one revolution. The shortest period, that of δ *Equulei,* is nearly six years. There are only thirty or forty whose periods are known to be less than one hundred years, and in the great majority of cases the periods will be expressed in hundreds and thousands of years.

The invention of the spectrograph, and its application to the measurement of stellar velocities of approach and recession, have enabled us to make a most interesting extension of our knowledge of binary systems. We are enabled to discover companion stars so close together that the most powerful telescope cannot separate them. In fact, their discovery becomes easier as the distance between the components becomes less. In the past few years more than a hundred such systems, known as spectroscopic binaries, have been discovered at a few of the leading observatories. It has in fact been established that, of the stars visible to the naked eye, at least one star in six is attended by an invisible companion, each so close to the bright component that the companion cannot be directly observed. In these systems the periods of revolution vary from one or two days, as a minimum, to a few years, as a maximum. For example, in the case of the North Pole star, the bright star and

an invisible companion revolve around each other in a period of four days, and this binary system and a second invisible component revolve around each other in from ten to twenty years. Easily the most interesting of all stellar systems thus far studied is that of *Castor,* as described above. It does not follow that the two invisible members of this quadruple system are really dark bodies. If they are two or three magnitudes fainter than the bright components, they would be invisible; for their light would be lost in that of the principal stars.

It should be said that the great value of the discovery of this interesting system lies not so much in the discovery itself as in the opportunity thereby afforded to study it thoroughly.

November 25, 1904. W. W. CAMPBELL.

A DIVISION OF THE STARS IN SOME OF THE GLOBULAR CLUSTERS, ACCORDING TO MAGNITUDE.

The programme of observations for the Crossley reflector undertaken by the late Professor KEELER contained eight well-known globular star-clusters.

The general appearance of these clusters is very similar; they are of nearly the same angular dimensions, and the magnitudes of the component stars are remarkably alike.

In each of these clusters practically all of the stars can be separated into two classes of magnitudes. Perhaps a third of the whole number lie between eleventh and thirteenth magnitude, while almost all of the remainder are very faint, being about sixteenth magnitude. The appearance is that of two layers, one of bright stars superposed upon another of very faint stars.

But few stars of magnitudes fourteen to fifteen and one half are to be found in these clusters.

Photographs of the ω *Centauri* cluster obtained at the Harvard College Observatory station at Arequipa exhibit the same division of the stars in that cluster into two groups, as does the Crossley series. The limits of the area of the faint stars are fully as sharply defined as those of the brighter ones, and the centers of the two groups coincide. We are therefore led to the conclusion that in each case the observed division is in the same group of stars in space. That it is characteristic of all clusters of this type is not certain, but the lack of any